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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/629,780	07/31/2000	Yowjuang W. Liu	5251	4875

7590 08/25/2003

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EXAMINER

PIZARRO CRESPO, MARCOS D

ART UNIT

PAPER NUMBER

2814

DATE MAILED: 08/25/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

AK

Office Action Summary	Application No.	Applicant(s)	
	09/629,780	LIU ET AL.	
	Examiner	Art Unit	
	Marcos D. Pizarro-Crespo	2814	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --
Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 15 July 2003.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 16-35 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☒ Claim(s) 19 and 28-35 is/are allowed.
- 6) ☒ Claim(s) 16-18 and 20-27 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on _____ is: a) ☐ approved b) ☐ disapproved by the Examiner.
If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
* See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- | | |
|--|---|
| 1) <input type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413) Paper No(s). _____ |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152) |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____ | 6) <input type="checkbox"/> Other: _____ |

Application/Control Number: 09/629,780 (Final Rejection)
Art Unit: 2814

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Attorney's Docket Number: AMD-C553397.DIV

Filing Date: 7/31/2000

Claimed Priority Date: 3/30/1998 (Divisional 09/052,057)

Applicant(s): Liu et al.

Examiner: Marcos D. Pizarro-Crespo

DETAILED ACTION

This Office action responds to the amendment in paper no. 15 filed on 7/15/2003.

Acknowledgment

1. The amendment in paper no. 15, filed on 7/15/2003, in response to the Office action in paper no. 14, mailed on 4/10/2003, has been entered. The present Office action is made with all the suggested amendments being fully considered. Accordingly, pending in this Office action are claims 16-35.

Claim Rejections - 35 USC § 103

2. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

3. This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was

not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

4. Claims 16, 17, 18, 21, 22, 24, 25, and 27 are rejected under 35 U.S.C. 103(a) as being unpatentable over Acovic (US 5315142) in view of Lin (US 6127226) and Jaeger.

5. Regarding claim 16, Acovic (see, e.g., figs. 2-12) shows most aspects of the instant invention including a method of fabricating a semiconductor device with a trenched gate comprising:

- forming an oxide layer **215** on the surface of a semiconductor substrate **130**
- forming a nitride layer **210** on the oxide layer **215**
- etching a trench **45** having substantially upright vertical sidewalls and a bottom surface in the substrate **130**
- forming a trench-to-gate insulating layer inside the trench **45**
- forming a trenched gate electrode **110** on the insulating layer
- forming source/drain regions **47, 50** in the substrate **130** such that the regions partially extend laterally underneath the bottom of the trench **45**
- forming an inter-gate dielectric layer **115** on the top surface of the trenched gate electrode **110**
- forming a control gate electrode **40** on the top surface of the inter-gate dielectric layer **115**

wherein the insulating layer comprises a trench gate dielectric spacer **100** formed on the upright vertical sidewalls inside the trench **45** and a trench gate tunneling dielectric **105** formed on the bottom surface inside the trench **45**.

Acovic, however, fails to show a step of implanting the substrate to form sidewall dopings in the substrate that laterally space the source/drain regions from the trench.

Lin, on the other hand, shows (see, e.g., fig. 5B) a step of implanting a semiconductor substrate **12** to form sidewall dopings **22** in the substrate **12** (see, e.g., fig. 9B). Moreover, Lin teaches that this step is a threshold implantation step (see, e.g., col.4/ll.65).

Along these lines, Jaeger (see, e.g., pp.178) teaches that the threshold voltage is ~~directly related to the substrate doping~~ and that there are several tradeoffs involved in the choice of substrate doping. According to Jaeger (see, e.g., pp.178), Lin's threshold implantation step is routinely used in the art to separate the threshold-voltage design from other factors involved in the choice of substrate doping.

Consequently, it would have been obvious at the time of the invention to one of ordinary skill in the art to include in Acovic's method Lin's suggested step of implanting the substrate to form sidewall dopings since, as taught by Jaeger, this step is routinely used in the art to separate threshold voltage design considerations from other factors involved in the choice of substrate doping.

6. Regarding claim 17, Acovic shows the step of forming the trenched gate electrode further comprising the steps of:

- depositing a layer **110** of polysilicon on the insulating layer inside the trench

45 (see, e.g., fig. 10)

- planarizing the layer **110** of polysilicon to a substantially planar orientation with a top surface of the substrate **130** (see, e.g., fig. 11)

7. Regarding claim 18, Lin shows (see, e.g., fig. 6B) the sidewall dopings laterally spacing each of the source and drain regions from the trench.

8. Regarding claim 21, Acovic shows that the nitride is silicon nitride (see, e.g., col.6/ll.14).

9. Regarding claim 22, Acovic shows most aspects of the instant invention (see paragraphs 8-13 above). In addition, Acovic discloses that the nitride layer is ~~approximately 1000 Å thick (see, e.g., col.6/ll.15), instead of 1500 Å thick, as recited in~~

claim 22. Although the claimed thickness and the prior art thickness do not overlap, it has been held that a *prima facie* case of obviousness exists where the claimed and prior art ranges do not overlap but are close enough that one skilled in the art would have expected them to have the same properties. It appears that the differences in thickness between Acovic and the claimed invention produce no change in the properties of the nitride layer and therefore would have been obvious (*Titanium Metals Corp of America v. Banner*, 778 F.ed 775, 227 USPQ 773 (Fed. Cir. 1985)).

10. Regarding claim 24, Acovic shows the method further comprising a step of planarizing the trenched gate electrode using the nitride layer as a stop for the planarization process (see, e.g., col.6/ll.45-48).

11. Regarding claim 25, Acovic shows the method further comprising a step of removing the nitride layer using plasma etch (see, e.g., col.6/ll.65-66).

12. Regarding claim 27, Acovic further shows that the trench may be 5000 Å deep (col.6/ll.22).

13. Claim 20 is rejected under 35 U.S.C. 103(a) as being unpatentable over Acovic in view of Lin, Jaeger and Wolf (US 3873371).

14. Regarding claim 20, Lin shows that the sidewall dopings are ion implanted at an angle to assure that the substrate sidewalls are implanted at the right dosage (see, e.g., fig. 5B; col.4/ll.64-col.5/ll.3). Lin, however, fails to specify that the angle of implantation be between 15-57°. Angle differences, however, are considered obvious design choices and are not patentable unless unobvious or unexpected results are obtained from these changes.

Wolf (see, e.g., col.2/ll.10-14), for example, teaches that the angle of implantation is a design variable that, if properly chosen, allows controlling the location at which the implanted impurities are introduced into the semiconductor substrate.

Consequently, it would be an obvious matter of design choice to select a suitable angle to implant the sidewall dopings of Acovic/Lin/Jaeger, as taught by Wolf, since this angle is a variable of importance subject to routine experimentation and optimization and it is not inventive to discover the optimum or workable ranges by routine experimentation. *In re Aller*, 220 F.2d 454, 105 USPQ 233, 235.

15. Claim 23 is rejected under 35 U.S.C. 103(a) as being unpatentable over Acovic in view of Lin, Jaeger, and Moon (US 5719085).

16. Regarding claim 23, Acovic/Lin/Jaeger shows most aspects of the instant invention (see paragraphs 5-12 above). In addition, Acovic shows that the oxide layer is 400 Å thick (see, e.g., col.6/ll.13), instead of the claimed thickness of 100 Å. This oxide layer provides an etch stop for a subsequent silicon nitride removal step (see, e.g., col.6/ll.60-63). In a similar method, Moon (col.3/ll.62-col.4/ll.2) teaches the use of a 100-Å-thick oxide layer as an etch stop for the removal of silicon nitride. As suggested by Moon, it appears that the differences in thickness between Acovic and the claimed invention produce no change in the properties of the oxide layer and therefore would have been obvious (*Titanium Metals Corp of America v. Banner*, 778 F.2d 775, 227 USPQ 773 (Fed. Cir. 1985)).

17. Claim 26 is rejected under 35 U.S.C. 103(a) as being unpatentable over Acovic in view of Lin, Jaeger, and Sharma (US 5382540).

18. Regarding claim 26, Acovic/Lin/Jaeger shows most aspects of the instant invention (see paragraphs 5-12 above), except for the trench's width ranging between 100-5000 Å. Acovic (see, e.g., col.6/ll.22), however, shows that the trench has a depth of approximately 5000 Å. As Sharma teaches (see, e.g., col.9/ll.20-30), it is important to choose the proper aspect ratio for Acovic's trench, i.e., the depth to width ratio, in order to facilitate its formation and to avoid voids within subsequently deposited layers.

Consequently, it would be an obvious matter of design choice to select an appropriate width for Acovic's trench, as taught by Sharma, since this width is a variable of importance subject to routine experimentation and optimization, and it is not inventive

to discover the optimum or workable ranges by routine experimentation. *In re Aller*,
220, F.2d 454, 105 USPQ 233, 235.

Allowable Subject Matter

19. Claims 19 and 28-35 are allowed.

Response to Arguments

20. The applicants argue:

One with normal skill in the art would not find motivation to combine Lin and Acovic. Acovic and the present invention are directed to horizontal transistor device, in which the current flows in the channel underneath the bottom of the trench. On the other hand, Lin is directed to a vertical transistor device, with a channel that is adjacent to the sidewalls, not underneath the bottom of the trench.

The examiner responds:

Lin's invention also covers horizontal transistors in which the current flow is in a channel underneath the bottom of the trench. See, e.g., col.4/ll.55-63 and col.5/ll.59-61.

21. The applicants argue:

The sidewall doping of the present invention is used to reduce coupling between the source and drain regions and the control gate, not to adjust the threshold voltage.

The examiner responds:

Intended use and other types of functional language must result in a manipulative difference between the claimed method and the prior art in order to patentably distinguish between them. If the prior art method step is capable of performing the intended use, then it meets the claim. *In re Casey*, 152 USPQ 235 (CCPA 1967); *In re Otto*, 136 USPQ 458, 459 (CCPA 1963). In the instant case, there is no apparent manipulative difference between the claimed method step and the prior art since they both show the step of forming sidewall dopings in the substrate laterally spacing each of the source and drain regions from the trench. See, e.g., Lin, fig. 6B.

Conclusion

22. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

23. A shortened statutory period for reply to this final action is set to expire **THREE MONTHS** from the mailing date of this action. In the event a first reply is filed within **TWO MONTHS** of the mailing date of this final action and the advisory action is not mailed until after the end of the **THREE-MONTH** shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any

extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than **SIX MONTHS** from the date of this final action.

24. Papers related to this application may be submitted directly to Art Unit 2814 by facsimile transmission. Papers should be faxed to Art Unit 2814 via the Art Unit 2814 Fax Center located in Crystal Plaza 4, room 3C23. The faxing of such papers must conform to the notice published in the Official Gazette, 1096 OG 30 (15 November 1989). The Art Unit 2814 Fax Center number is **(703) 308-7722** or **-7724**. The Art Unit 2814 Fax Center is to be used only for papers related to Art Unit 2814 applications.

25. Any inquiry concerning this communication or earlier communications from the examiner should be directed to **Marcos D. Pizarro-Crespo** at **(703) 308-6558** and between the hours of 9:30 AM to 8:00 PM (Eastern Standard Time) Monday through

Art Unit: 2814

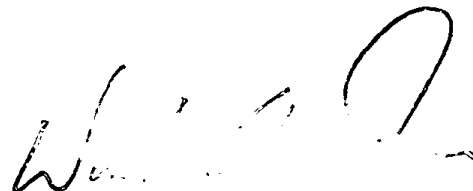
Thursday or by e-mail via Marcos.Pizarro@uspto.gov. If attempts to reach the

examiner by telephone are unsuccessful, the examiner's supervisor, Wael Fahmy, can be reached on (703) 308-4918.

26. Any inquiry of a general nature or relating to the status of this application should be directed to the **Group 2800 Receptionist** at **(703) 308-0956**.

27. The following list is the Examiner's field of search for the present Office Action:

Field of Search	Date
U.S. Class / Subclass(es): 438/257-267, 257/314-326	8/19/2003
Other Documentation:	
Electronic Database(s): EAST (USPAT, EPO, JPO)	8/19/2003


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